The effect of Aerobic Exercise and Selected Yogic Asanas on TSH, Thyroxine, Triiodothyronine and blood glucose levels in subclinical Thyroid Patients: A study on sedentary Adult women.

SYNOPSIS

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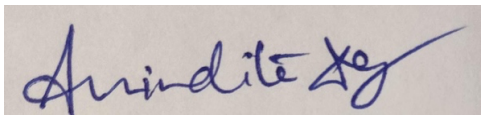
CERTIFICATE

I hereby declare that the short synopsis titled "Effect of Aerobic Exercise and Selected Yogic Asanas on TSH, Thyroxine, Triiodothyronine and Blood Glucose Levels in Subclinical Thyroid Patients: A Study on Sedentary Adult Women" is being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Physical Education under the Dept. of Physical Education Pedagogy, Lakshmibai National Institute of Physical Education, Gwalior. of during the academic year 2022-23.

It is a bonafide record of original work carried out under the supervision of Dr. Anindita Das and has not been submitted in full or part to any other university or institute for a degree or diploma.

ATISHA MANDAL



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Abstract

The increasing prevalence of subclinical hypothyroidism among sedentary adult women has become a major public health concern, particularly due to its association with metabolic disorders and hormonal imbalances. This study investigates the effect of aerobic exercise and selected yogic asanas on key thyroid hormones—Thyroid Stimulating Hormone (TSH), Thyroxine (T4), Triiodothyronine (T3)—and blood glucose levels in women aged 35–55 years diagnosed with subclinical hypothyroidism. Employing a randomised controlled trial design, 30 participants were divided into an experimental group (receiving a 12-week structured intervention of aerobic exercise and yogic practices) and a control group (maintaining their sedentary lifestyle). Blood samples were collected at baseline, mid-intervention, and post-intervention to measure hormonal and glucose levels. The study hypothesises that aerobic exercise combined with yogic asanas will increase T3 and T4 levels, reduce TSH and blood glucose, and improve endocrine function. The results aim to contribute to the growing body of evidence supporting non-pharmacological lifestyle interventions for managing subclinical thyroid dysfunction and enhancing metabolic health in adult women.

Key Words: Hypothyroidism, Aerobic Exercise, Yogic asanas

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1. INTRODUCTION

The endocrine system is a complex network of glands and hormones that regulate various physiological processes in the body. Thyroid hormones, such as thyroxine (T4), triiodothyronine (T3), and calcitonin, are crucial for maintaining metabolic and skeletal health. A sedentary lifestyle has been linked to imbalances in these hormones, leading to various health complications.

The thyroid gland is a small, butterfly-shaped gland located in the neck that plays a crucial role in regulating metabolism and maintaining overall health. This gland produces several hormones that control various bodily functions, including growth and development, body temperature, heart rate, and energy production. The two primary hormones secreted by the thyroid gland are thyroxine (T4) and triiodothyronine (T3), which are synthesised from iodine and the amino acid tyrosine.

Thyroid hormone synthesis and secretion are highly regulated processes involving a complex interplay of various factors, including the hypothalamus, pituitary gland, and thyroid gland. The hypothalamus produces thyrotropin-releasing hormone (TRH), which stimulates the pituitary gland to release thyroid-stimulating hormone (TSH). TSH, in turn, stimulates the thyroid gland to produce and secrete T4 and T3. Feedback mechanisms regulate the production and secretion of these hormones, ensuring the body maintains a steady state of thyroid hormone levels.

Imbalances in thyroid hormone levels can have significant effects on overall health and well-being. Hypothyroidism, or an underactive thyroid gland, can result in symptoms such as fatigue, weight gain, constipation, and depression. Hyperthyroidism, or an overactive thyroid gland, can cause symptoms such as weight loss, rapid heartbeat, tremors, and anxiety. Both conditions can be diagnosed through blood tests measuring thyroid hormone levels, and treatment may involve medication, surgery, or other interventions.

The modern sedentary lifestyle is often associated with several health complications, including hormonal imbalances. The endocrine system plays a crucial role in regulating several physiological processes in the body, including metabolism, growth, and development. Hormones such as thyroxin, triiodothyronine, and calcitonin are critical components of this system and play a crucial role in regulating metabolic processes.

Thyroid disorders are common among sedentary adult women, and they can lead to a range of symptoms and health complications. Sedentary lifestyle is associated with an increased risk of thyroid disorders because lack of physical activity can cause weight gain, which is a significant risk factor for thyroid disorders. Furthermore, sedentary behavior can also lead to hormonal imbalances that can affect the thyroid gland.

Hypothyroidism is the most common thyroid disorder among sedentary adult women. It occurs when the thyroid gland does not produce enough thyroid hormone, leading to a slower metabolism and a range of symptoms such as fatigue, weight gain, and depression. Other thyroid disorders that are prevalent among sedentary adult women include hyperthyroidism, thyroid nodules, and thyroid cancer.

Aerobic capacity, also known as cardiorespiratory fitness, refers to the ability of the body to utilize oxygen efficiently during physical activity. It is a key component of overall physical fitness and is essential for maintaining good health and well-being. Aerobic capacity is influenced by a number of factors, including genetics, age, gender, and lifestyle choices such as diet and exercise.

Aerobic capacity is typically measured by assessing an individual's maximal oxygen uptake (VO2 max), which is the highest amount of oxygen that a person can consume during exercise. This measurement is commonly used to evaluate an individual's aerobic fitness level and can be used to monitor changes in fitness over time.

Aerobic capacity plays a critical role in overall health and wellness, as it is closely linked to a number of important health outcomes. For example, individuals with high levels of aerobic fitness are at lower risk for a variety of chronic diseases, including cardiovascular disease, diabetes, and certain types of cancer. Additionally, aerobic fitness has been shown to have a positive impact on mental health outcomes such as anxiety, depression, and cognitive function.

Thyroid hormones play a crucial role in regulating metabolism, energy expenditure, and body weight. Aerobic training, also known as cardio, has been shown to have a positive impact on thyroid hormone levels. Regular aerobic exercise can increase thyroid hormone production, which can help improve overall health and wellness. In this introduction, we will explore the relationship between aerobic training and thyroid hormones, including the benefits of aerobic exercise for thyroid function, the effects of different types of aerobic exercise on thyroid hormones, and the potential implications for individuals with thyroid disorders.

Aerobic training has been shown to have a positive impact on thyroid hormone levels. Regular aerobic exercise can increase thyroid hormone production, which can help improve overall health and wellness. One of the primary mechanisms by which aerobic exercise affects thyroid hormone levels is by increasing the production of TSH. TSH stimulates the thyroid gland to produce T3 and T4, and regular aerobic exercise can increase the sensitivity of the thyroid gland to TSH.

Regular aerobic exercise has many benefits for thyroid function. One of the primary benefits is an increase in thyroid hormone production, which can help improve metabolism and energy expenditure. Regular aerobic exercise can also improve insulin sensitivity, which can help prevent type 2 diabetes, a common complication of thyroid disorders. Additionally, aerobic exercise can help reduce inflammation, which is often elevated in individuals with thyroid disorders.

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Effects of Aerobic Exercise on Thyroid Hormones:

The effects of aerobic exercise on thyroid hormones have been investigated in several studies. The available literature suggests that aerobic exercise can have both short-term and long-term effects on thyroid function. The short-term effects of aerobic exercise on thyroid hormones are mainly due to the body's response to the increased energy demands during exercise, while the long-term effects are related to the body's adaptation to regular physical activity.

Short-term effects:

The short-term effects of aerobic exercise on thyroid hormones are mainly due to the body's response to increased energy demands during exercise. During exercise, the body requires more energy to fuel the increased metabolic activity. This increased energy demand is met by the breakdown of glycogen and the mobilization of fatty acids from adipose tissue. To meet this

increased energy demand, the thyroid gland increases the production of T3 and T4 hormones, leading to an increase in overall metabolic rate. This increase in metabolic rate helps the body meet the increased energy demands during exercise and allows for more prolonged periods of physical activity.

Additionally, during exercise, there is an increase in sympathetic nervous system activity, leading to the release of catecholamines, such as epinephrine and norepinephrine. These catecholamines stimulate the thyroid gland, leading to an increase in T3 and T4 hormone production. The increase in catecholamines during exercise also promotes the breakdown of glycogen and the mobilization of fatty acids from adipose tissue, providing more energy to fuel the increased metabolic activity during exercise.

Long-term effects:

The long-term effects of aerobic exercise on thyroid hormones are related to the body's adaptation to regular physical activity. Regular physical activity leads to several adaptations in the body, including changes in hormone levels. In particular, regular aerobic exercise has been shown to increase the production of T3 and T4 hormones, leading to an increase in overall metabolic rate.

Regular aerobic exercise has also been shown to increase the sensitivity of the thyroid gland to TSH (thyroid-stimulating hormone). TSH is produced by the pituitary gland and stimulates the thyroid gland to produce T3 and T4 hormones. Increased sensitivity to TSH means that the thyroid gland is more responsive to the body's hormonal signals, leading to more efficient hormone production and regulation.

Aerobic exercise and yoga have emerged as popular non-pharmacological interventions to promote physical fitness and overall well-being. Several studies have investigated the effects of these interventions on hormonal imbalances in different populations. However, there is limited research available on the effects of aerobic exercise and selected yogic asanas on hormonal imbalances in sedentary adult women.

The present study aims to investigate the effect of aerobic exercise and selected yogic asanas on thyroxin, triiodothyronine, and calcitonin hormones in sedentary adult women. This research is essential, given the increasing prevalence of sedentary lifestyles and the associated health complications.

The study will adopt a randomized controlled trial design, where participants will be assigned to either an experimental group or a control group. The experimental group will undergo a 12-week intervention, consisting of aerobic exercise and selected yogic asanas. The control group will maintain their regular sedentary lifestyle.

The primary outcome measures will be the levels of TSH, thyroxin, triiodothyronine, and calcitonin hormones and blood glucose level assessed before and after the 12-week intervention.

The study's findings will provide valuable insights into the effects of aerobic exercise and selected yogic asanas on hormonal imbalances in sedentary adult women. The results will have significant implications for developing effective interventions to manage hormonal imbalances and associated health complications in sedentary adult women.

In conclusion, this study aims to investigate the effect of aerobic exercise and selected yogic asanas on TSH, thyroxin, triiodothyronine, and calcitonin hormones and blood glucose level in sedentary adult women. The study's findings will contribute to the growing body of literature on the effectiveness of non-pharmacological interventions for managing hormonal imbalances in different populations.

2. LITERATURE REVIEW

It can be inferred from the works that(Mohan & Pal, 2022)the beneficial effect of Yoga on the parameters of thyroid hormone has been evaluated through various clinical trials. Since its review has not been recorded earlier, this study has been performed to investigate the effectiveness of Yogic practices on thyroid hormones, more specifically T3, T4, and TSH. A total of 41 studies were selected through various searches, among which 11 met criteria for the final review. Hypothyroid patients showed a decrease in thyroid-stimulating hormone (TSH), hyperthyroid patients showed a decrease in tetraiodothyronine (T4), and the polar triiodothyronine (T3) syndrome population also showed a positive effect of Yoga. Perimenopausal women showed a not-so-significant change in these parameters. Healthy middle-aged individuals showed an increase in TSH in the male population, and a near-significant increase in this hormone was shown in the female population. Also, there was a decrease in basal T3 and T4 in both males and females. 1 study was done on hypothyroid patients using hand mudra only, which showed significant changes in the level of these parameters. In conclusion, it may be stated that yogic practice may regularise thyroid hormone functioning and improve total health.

(Altaye et al., 2019) aimed to investigate the impact of a 16-week aerobic exercise programme on the changes in the plasma concentration of thyroid hormones in adolescents with intellectual disabilities. The training programme consisted of 16 weeks of moderate-intensity aerobic exercises at an intensity of 45–75%. The plasma levels of triiodothyronine (T3), tetraiodothyronine (T4), and thyroid-stimulating hormone were measured before and after 16 weeks of aerobic exercise intervention. And finally, they concluded that aerobic exercise had an impact on the change in the plasma level concentration of thyroid and thyroid-stimulating hormones in adolescents with intellectual disabilities.

Another study has investigated the effect of acute aerobic exercise on thyroid hormone values. The effect of different intensity levels of acute aerobic exercise on thyroid hormones was investigated in 60 male well-trained athletes by performing bicycle ergometry at 45% (low intensity), 70% (moderate intensity), and 90% (high intensity). At each intensity level, heart rate, blood lactic acid, serum total thyroxine (T4), free thyroxine (ft4), total triiodothyronine (T3), free triiodothyronine (ft3) and thyroid stimulating hormone (TSH) values were measured. The results of this study show that exercise performed at the anaerobic threshold (70% of maximum heart rate, lactate level 4.59 +/- 1.75 mmol/l) caused the most prominent changes in the amount of any hormone values. While the rate of T4, ft4, and TSH continued to rise at 90% of maximum heart rate, the rate of T3 and ft3 started to fall. Maximal aerobic exercise greatly affects the level of circulating thyroid hormones.(Ciloglu et al., 2005)

In the topic The Effect of Acute and Chronic Exercise on Thyroid Hormones in Obesity, thyroid hormones were measured before, during and after acute exercise (60 min) or physical training (3 months) in obese women. Thyroid-stimulating hormone concentration increased during acute work and decreased immediately after. No changes were seen during the two following days. An increase was seen after ten days as well as after three months of physical training. Thyroxine concentrations showed no changes. 3,5,3′-Triiodothyronine decreased slightly immediately after

acute exercise, and after three months of physical training, 3,3′,5′-triiodothyronine (reverse triiodothyronine) increased slowly during and after acute exercise. A negative correlation was found between changes in fasting insulin and thyroxine and a positive correlation between changes in blood pressure and triiodothyronine after training.
The aim of this study was to evaluate the effect of aerobic exercises on the thyroid hormones in treated hypothyroid pregnant women. A total of 42 pregnant women with treated hypothyroidism. Their age was ranged from 25 to 35 years and their body mass index was ranged from 30 to 35 kg/m2 . They were randomly distributed into two groups. The control group received thyroxine replacement doses (100 µg/day), and the exercise group received the same medical treatment and participated in a program of aerobic exercises for 12 weeks. TSH level was significantly reduced (p=0.0001) in the control and the exercise groups post-treatment, this reduction was in favor of exercise group. While FT4 level was significantly increased (p=0.0001) in the exercise group without significant difference (p=0.639) in the control group. Abbas et al.,2019
It can be conclude from the works of (Singh et al., 2011), Patients' quality of life scores following the yoga program were greater than scores obtained prior to undertaking yoga ($p < 0.01$). Patients also reported significant improvement in their perception of the overall quality of life and of their health post yoga intervention of their study headed effect of yoga on the quality of life of female hypothyroid patients. The WHO Quality of Life Scale was used to assess the quality of life of 20 female hypothyroid patients. Subjects attended one hour yoga sessions daily for a period of one month. A pretest–post-test research design was used for data analysis. It can be concluded that yoga is valuable in helping the hypothyroid patients to manage their disease-related symptoms. Yoga may be considered as supportive or complementary therapy in conjunction with medical therapy for the treatment of hypothyroid disorder.
Thyroid hormone responses to acute maximal aerobic exercise are still unclear, so the aim of the study is to investigate the effect of acute maximal aerobic exercise resulting in fatigue on blood thyroid levels in men and women. The study included 8 male and 7 female subjects who did not actively exercise. The subjects warmed up for ten minutes before they had a 20 m shuttle run. The purpose of this test was to tire the subjects to exhaustion. The heart rate was measured at the end of the test in order to determine the exhaustion levels of the participants. The 5 cc. venous blood samples were taken again just after the exhaustion exercise. When results were compared between both sexes, no significant difference was found among variables ($p>0.05$). There was a significant change in TSH values in all groups. They increased following the exercise compared to pre-exercise values. Moreover, total T3 decreased in all groups. No other significant difference was found in free T3 and free T4 variables. In conclusion, thyroid responses to exercise emerge in a very complex way, which makes it difficult to reach a clear conclusion about its effects. The reason why the results are so contradictory is that the duration and intensity of the exercise, age, not being able to control the diet, and the timing of collection of blood samples after exercise.(Akgül&Baydil, 2021).
The study done (Kiani et al., 2020) on the topic, The Effects of Moderate Intensity Aerobic Training on Serum Levels of Thyroid Hormones in Inactive Girls. The aim of this study to investigate the effect of moderate intensity aerobic training on thyroid hormone levels in inactive girls. A total of 30 inactive female students were randomly selected and divided into a training group (n=15) and a control group (n=15). The training group was doing a research protocol for four weeks (three sessions per week of 70% maximal heart rate), and the control group was not intervened during the study. However, the elevation anthropometric index was measured before

the protocol training study. Blood samples were collected 24 hours before the first and after the last training session. For the analysis, data was used to test the significance at a $p<0.05$ level. Results showed a significant reduction of T3 ($P<0.05$), but no significant changes were observed at T4, TSH, and FT4 levels after training ($P>0.05$). Their results showed that moderate aerobic training of 70% maximal heart rate has a minimum effect on thyroid hormones in inactive adolescent girls.

A study was designed to examine the effect of Hatha yoga therapy and regular physical exercise on the Fasting Blood Sugar (FBS), Glycated Haemoglobin (Hba1c), Thyroid Stimulating Hormone (TSH), serum cortisol and total plasma thiol levels in perimenopausal women. The duration of the intervention was 45 minutes every day for 12 weeks. Blood samples were collected in the pre- and post-intervention period. Statistical significance was defined as $p<0.05$. FBS and GHB ($p\leq0.05$) showed a significant decrease after yoga therapy. Cortisol levels significantly ($p\leq0.05$) increased in the post-intervention period in the control group. However, it is maintained in the test group between the two time periods. The total plasma thiols level showed a rise in the post-intervention period, a significant rise ($p\leq0.001$) in the control group but not in the test group. The TSH levels were not altered in any group.(Chaturvedi, 2016).

A study (Nilakanthan et al., 2016) aimed to study the effect of 6 months of yoga practice on lipid profile, thyroxine requirement and serum TSH in women suffering from hypothyroidism. Twenty-two household women suffering from hypothyroidism between the age range of 30 and 40 (mean±SD; 36.7±3.2) years, with average 4±1.12-year history of hypothyroidism were included in this study. None of the subjects were on any other medication except thyroxine, which was kept during the intervention phase (mean 65.78±22.74 mcg). All the subjects underwent 6 months of yoga practice, 1 h daily, for 4 days a week. Lipid profile, thyroxine dosage and serum TSH level were assessed before and after intervention. 6 months of practice of yoga may help in improving cholesterol level, serum TSH, and may also help in improving the thyroxine requirement in female patients suffering from hypothyroidism. However, further randomised controlled studies need to be conducted to confirm the present finding.

The aim of this study was to assess the effect of eight weeks of aerobic training on thyroid hormones and quality of life in obese postmenopausal women. In this semi-experimental study, 21 obese (body mass index >30 Kg/m2) women aged between 35 and 45 were randomly divided into an experimental (n=10) group and a control group (n=11). The subjects in the experimental group performed 30-60 minutes of aerobic exercise at 65-75% of maximum heart rate, three times a week, for eight weeks. The levels of thyroid hormones and quality of life subscales were compared within and between the groups. Statistical analysis was performed at the significance level of 0.05. After the eight-week exercise program, thyroxine, triiodothyronine, and thyrotropin-releasing hormone levels increased significantly, and thyroid-releasing hormone levels decreased significantly ($P=0.001$). The exercise program also had significantly positive effects on quality of life and its occupational, sexual and emotional subscales in obese postmenopausal women. They (Fathi et al., 2018)concluded that Aerobic exercise causes a significant increase in levels of thyroxine, triiodothyronine and thyrotropin-releasing hormone and some subscales of quality of life. It also causes a significant decrease in thyroid-releasing hormone level, which indicates the effect of exercise on hormone secretion.

Effect of the Marine Exercise Retreat Program on Thyroid-Related Hormones in Middle-Aged Euthyroid Women.(Byeon et al., 2023). This study aimed to investigate the effects of a marine exercise retreat program on thyroid-related hormone levels. A total of 62 middle-aged euthyroid women participated in a 6-day marine exercise retreat program. Using thyroid-stimulating

hormone (TSH) and free thyroxine (FT4) hormone levels, the participants were divided into high and low-hormone-level groups. TSH levels were influenced by changes in the normalised low frequency (nlf) of heart rate variability and carbon monoxide (CO) from all the participants, and changes in body fat percentage, nlf, and nitrogen dioxide (NO2) exposure level in the high TSH group. FT4 levels were influenced by changes in body mass index (BMI), NO2 exposure, and particulate matter diameter of 10 μm or less (PM10) exposure in all participants. Changes in BMI and CO exposure influenced the low ft4 group. Lastly, changes in the exercise stress test affected the high ft4 group. Thus, the marine exercise retreat program affected euthyroid thyroid-related hormone levels, and influencing factors differ depending on the initial value of the hormone.

A study (Rani et al., 2021)investigated the effect of a 3-month integrated yoga intervention (3-IY) on depression, lipid indices, and serum thyroid-stimulating hormone (stsh) levels among female patients having hypothyroidism, and mild-to-moderate depression. The present single-arm pre-post design study was conducted in thirty-eight women (average age 34.2 ± 4.7 years). Participants received a 3-IY comprising asanas, pranayama, and relaxation techniques for 60 min daily (5 days a week). Depression, sTSH, lipid profile indices, Body Mass Index (BMI), fatigue, anxiety, and stress were assessed at baseline and after 12 weeks. Thyroid medication was kept constant during the study period. Data were analysed using R Studio software. A significant ($P < 0.05$) reduction in depression (58%), sTSH (37%), BMI (6%), fatigue (64%), anxiety (57%), lipid profile indices (HLD increased significantly), and stress (55%) levels was observed after 3 months, compared with the corresponding baseline levels. The 3-IY is useful for reducing depression, dyslipidaemia, and sTSH in women with hypothyroidism and depression. Also, they suggested that further studies with a larger sample size and a robust research design using objective variables must be conducted to strengthen the study findings.

A study covered by Abassi et al. (2020 investigated the effects of 12-week high-intensity interval training (HIIT) vs. moderate-intensity interval training (MIIT) on thyroid-stimulating hormone (TSH), thyroxine (T4) and insulin resistance in overweight/obese adolescent girls. Twenty four adolescent girls (age 16.5±1.36 yrs) were randomly allocated into three groups: (1) HIIT (2 blocks per session of 6–8 bouts of 30 s runs at 100–110% maximal aerobic speed (MAS), with 30 s active recovery between bouts at 50% MAS; n=8), (2) MIIT (2 blocks per session of 6–8 bouts of 30 s runs at 70–80% MAS, with 30 s active recovery between bouts at 50% MAS; n=8) and (3) control group (no exercise, n=8). Each training group engaged in three sessions per week for three months. Anthropometric parameters, aerobic capacity, homeostasis model assessment index for insulin resistance (HOMA-IR), as well as plasma TSH and T4 levels were assessed in all subjects before and after training. Twelve weeks of HIIT was effective in reducing circulating TSH and T4 levels, unlike MIIT, in overweight/obese adolescent girls. These findings indicated that the stimulation of pituitary-thyroid function is more sensitive to training intensity than training duration.

A study aimed to explore the effect of 8 weeks of concurrent aerobic-resistance training on thyroid stimulating hormone (TSH), thyroxine (T4), blood lipid profile, and blood glucose hemostasis in adolescent girls with hypothyroidism. In this clinical trial, 20 adolescent girls with hypothyroidism [age: 12.10 ± 1.94 years; body mass index (BMI): 25.25 ± 2.91 kg/m2] were selected and randomly assigned to experimental and control groups. The experimental group was treated with 8 weeks of concurrent aerobic [60–80% heart rate reserve (HHR)] and resistance (40–65% of 1RM) training. Blood was sampled before and after training. Data were analyzed using a pairwise t-test and an independent t-test ($\alpha < 0.05$). Within-group comparison revealed

significant decline of body index, BMI, fat percentage, fasting blood sugar, and homeostatic model assessment (HOMA) in the experimental group ($p = 0.002$, $p = 0.001$, $p = 0.001$, $p = 0.03$, and $p = 0.02$, respectively). Also, inter-group comparisons indicated significant differences in weight, BMI, fat percentage and HOMA ($p = 0.001$). But, no significant difference was observed in the blood sugar index ($p > 0.05$). A short-term period of concurrent aerobic-resistance training may improve blood glucose hemostasis and body composition of adolescent girls with hypothyroidism. However, further research is necessary.(MohammadiSefat et al., 2019)
Some study aims to investigate how exhaustion exercise affects thyroid hormones and testosterone levels in elite athletes who are supplemented with oral zinc sulfate for 4 weeks. The study included 10 male wrestlers who had been licensed wrestlers for at least 6 years. The mean age of the wrestlers who volunteered in the study was 18.70 +/- 2.4 years. All subjects were supplemented with oral zinc sulfate (3 mg/kg/day) for 4 weeks in addition to their normal diet. Thyroid hormone and testosterone levels of all subjects were determined as resting and exhaustion before and after zinc supplementation. Findings of our study demonstrate that exhaustion exercise led to a significant inhibition of both thyroid hormones and testosterone concentrations, but that 4-week zinc supplementation prevented this inhibition in wrestlers. In conclusion, physiological doses of zinc administration may benefit performance.(Kilic et al., 2006).
The present study aimed to explore the effect of water-based rhythmic exercise training on fasting blood sugar (FBS), homeostatic model assessment (HOMA), insulin, thyroid-stimulating hormone (TSH), and T4 in postmenopausal women with metabolic syndrome. In this clinical trial, 31 postmenopausal women with metabolic syndrome aged 69.16 ± 2.02 years were randomly assigned to an experimental (n=16) and a control group (n=15). The training program was composed of 12 weeks of water-based rhythmic exercise training performed intermittently for 60 minutes three times a week. Before and after training, blood was analysed for glucose homeostasis, T4, and TSH. Data were subjected to analysis by paired t-test and covariance analysis at the $p<0.05$ level. The exercise training intervention reduced the FBS and insulin significantly ($p=0.000$). The growth hormone (GH) index was increased significantly only in the experimental group ($p=0.037$), whereas no significant variations occurred in the insulin-like growth factor-1 ($p=0.712$). It was also found that TSH and T4 changed in the experimental group as compared to the pre-test. So, the conclusion is that Water-based rhythmic exercise training may improve blood glucose homeostasis, TSH, and T4.(Berahman et al., 2021)
The effects of maximal aerobic exercise on cortisol and thyroid hormones in male field hockey players. Some metabolic and endocrine functions might be influenced by exercise, and it leads to changes in the concentrations of hormone secretions in humans. In order to determine the changes of thyroid hormones (THs) related to shuttle run exercise (SRE), 14 field hockey players and their thyroid stimulating hormones (TSH) free T3 (fT3), free T4 (fT4) were included in this study, and cortisol levels were measured three times; before the exercise, just after the exercise and one hour later after exercise. The results of this study showed that there were no statistically significant differences among the three measurements in the serum levels of TSH and thyroid hormones. However, both ft3 and TSH were significantly decreased one hour after exercise, whereas no change was observed in ft4. Cortisol concentrations were slightly increased immediately after SRE. In conclusion, serum levels of thyroid stimulating hormone and thyroid hormones were affected by maximal aerobic exercise.(Beyleroglu, 2011).

3. STATEMENT OF THE PROBLEM

The purpose of this study is to see the "Effect of aerobic exercise and selected yogic asanas on TSH, thyroxin, triiodothyronine, hormones and blood glucose in subclinical hypothyroidism patients in sedentary adult women."

4. RESEARCH QUESTION

What will be the impact on TSH, t3, t4, hormones and blood glucose of practising aerobic exercises and selected yogic asanas on sedentary adult women with subclinical hypothyroidism between the age group of 35- 55 years?

5. OBJECTIVES OF THE STUDY

1. To find the effect of TSH, T3, T4, hormones and blood glucose.
2. To find out the effect of aerobic exercises and yogic asanas on sedentary adult women with subclinical hypothyroidism.
3. To promote thyroid gland health, TSH secretion and its balance.
4. To encourage an active lifestyle in sedentary adult women.

6. DELIMITATIONS

1. The study will be confined to sedentary adult women only.
2. The study is delimited to subclinical Hypothyroidism patients only.
3. The study will be delimited to the subject's age, aged 35- 55 years.
4. The study will be further delimited to 15 subjects in two groups.
5. The study will be delimited by aerobic exercise, such as running (Low to moderate), Suryanamaskara, and selected yogic asanas.

7. HYPOTHESIS

Based on literature and research, scholars' understanding, the following hypotheses are formulated:-

Ha1: It is hypothesised that "There will be an increment in T3, T4 serum levels in blood by doing aerobic exercises and asanas in sedentary adult women with hypothyroidism."

Ha2: It is hypothesised that "There will be a decrement in TSH in blood by doing aerobic exercises and asanas in sedentary adult women with hypothyroidism."

Ha3: It is hypothesised that "There will be an effect on blood glucose level in blood by doing aerobic exercises and asanas in sedentary adult women with hypothyroidism."

Ha4: It is hypothesised that "There will be a time effect on all the variables by doing aerobic exercises and asanas in sedentary adult women with hypothyroidism."

8. DEFINITIONS AND EXPLANATION OF TERMS

AEROBIC EXERCISE: Aerobic exercise, also known as cardio or cardiovascular exercise, refers to any physical activity that increases your heart rate and promotes the efficient use of oxygen by the body. It involves rhythmic and repetitive movements that engage large muscle groups, such as running, cycling, swimming, and dancing. Aerobic exercise is characterised by its ability to raise the breathing and heart rates for an extended period, typically at least 10 minutes.

ASANA:" Hathasyaprathamangtbadasanampurvamuchyate; kuryatdasanamstheormarogyamchanglaghabam." Hatha yoga pradipika 1:17. Means Asana spoken as the first part of Hatha yoga. Having done asana, one gets steadiness of the body and mind, diseaselessness and lightness of the body.

Meaning of Asana: The word asana means the posture intended for meditation. The word literary means a method of sitting. It is only later on that the other exercises in the system of asana, such as sirsasana, are performed. Thus, the asanas that bring about a state of equilibrium in the body should also be practised, though Patanjali does not mention them.

TSH: The thyroid-stimulating hormone (TSH), or thyrotropin, is produced and released by the pituitary gland in the brain. It plays a crucial role in regulating the function of the thyroid gland, acting on the thyroid gland to stimulate the production and release of thyroid hormones, namely thyroxine (T4) and triiodothyronine (T3). These hormones are essential for maintaining the body's metabolism, growth, and development.

THYROID GLAND: The thyroid gland is a small, butterfly-shaped organ in the neck. It plays a crucial role in regulating metabolism and controlling the body's energy production. The gland produces hormones, such as thyroxine (T4) and triiodothyronine (T3), influencing various bodily functions, including growth, development, and temperature regulation. Disorders of the thyroid gland, such as hypothyroidism and hyperthyroidism, can lead to a wide range of symptoms and health complications.

T3: Triiodothyronine (T3) is a vital hormone produced by the thyroid gland. It plays a crucial role in regulating metabolism and energy production in the body. T3 influences various physiological processes, including growth, development, and the functioning of organs and tissues. It enhances protein synthesis and helps maintain body temperature and heart rate. The hypothalamus and pituitary gland tightly control T3 levels, ensuring optimal thyroid hormone function.

T4: Thyroxine, or T4, is a hormone produced by the thyroid gland. It plays a vital role in regulating metabolism, growth, and development in the body. Thyroxine helps control the rate at which cells use energy, influencing various bodily functions such as heart rate, body temperature, and digestion. It is essential for maintaining proper brain function and overall health. Imbalances in thyroxine levels can lead to conditions like hypothyroidism or hyperthyroidism, affecting a person's energy levels and metabolism.

BLOOD GLUCOSE: Blood glucose is the concentration of sugar (glucose) in the bloodstream. It is a vital parameter that helps regulate energy production in the body. Maintaining appropriate blood glucose levels is crucial for overall health and well-being. Imbalances, such as high blood glucose (hyperglycaemia) or low blood glucose (hypoglycaemia), can have significant

implications and are often associated with conditions like diabetes. Regular monitoring and proper management of blood glucose levels are essential for individuals to maintain optimal health.

9. SIGNIFICANCE OF THE STUDY

1. This study may support multiple aspects of hormonal health by stimulating TSH and the thyroid gland.
2. Knowledge about the effects of different yogic asanas and aerobic exercises like jogging will be enhanced after reading about this problem.
3. The knowledge regarding adequate precaution and prevention will be taken while doing asanas and aerobic exercises.
4. The relationship between exercise and the effects on the hormones will be observed through this study.
5. This study might be helpful for those who are suffering from hypothyroidism.
6. The study's findings will contribute to the growing literature on the effectiveness of non-pharmacological interventions for managing hormonal imbalances in different populations.

10.METHODOLOGY

This chapter describes the selection of subjects, selection of variables, administration of the test, collection of data and statistical techniques for data analysis.

10.1 Selection of Subjects

- Thirty subjects (aged between 35 and 55) would be further divided into two groups.

Group A: controlled group (15)

Group B: uncontrolled group (15)

10.2 Selection of Variables

The following are the test variables:

1. TSH hormone
2. Thyroxin hormone
3. Triiodothyroninehormone
4. Blood glucose.

10.3 Administration of the test

At first, the Researcher will ask subjects if any injury or immediate emergency has occurred to their body or if they feel uncomfortable with the blood test. After that, they will proceed with tests. The blood sample is taken from a vein in the arm using a small needle. After the needle is inserted, a small amount of blood will be collected into a test tube or vial.

10.4 Criterion Measure

For the study, these variables will be tested in

1. TSH in miu/ml (milli-international units per millilitre of blood).
2. T4: thyroxine in ug/dL (micrograms per deciliter of blood). FT4: Free thyroxin in ng/dL (nanograms per deciliter of blood).
3. T3: triiodothyronine in ng/dL (nanograms per deciliter of blood).
   FT3: Free triiodothyronine in pg/mL (pictograms per milliliter of blood).
4. Blood glucose: measured in mg/dL (milligrams per deciliter).

10.5 Data Collection Procedure

Thirty randomly selected sedentary adult women subjects will come to the pathology lab on the first day, and their TSH, thyroxin, triiodothyronine, and blood glucose will be recorded randomly through a blood collection. After that, the researcher will give 6 weeks of training in aerobic exercises and selected yogic asanas to the experimental group, and a mid-test will be done. Again, 6 weeks of training will be given to subjects. After completing the training, the researcher will administer a post-test by collecting data on the same variable in a blood sample.

10.6 Statistical Procedure

- Descriptive statistics (mean, standard deviation) will be used to analyse the data.
- Repeated measure ANOVA would be employed at a 0.05 significance level to analyse the effect over time.

11. Expected Outcome of the Research

This study aims to evaluate the effects of aerobic exercise and selected yogic asanas on thyroid hormones—TSH, T3, T4—and blood glucose levels in sedentary adult women with subclinical hypothyroidism. Based on existing literature and physiological mechanisms, several positive outcomes are expected from the 12-week structured intervention.

Firstly, a **significant decrease in TSH levels** is anticipated in the experimental group. Elevated TSH, common in subclinical hypothyroidism, indicates underactivity of the thyroid gland. Regular aerobic activity and yogic asanas are believed to stimulate the hypothalamic-pituitary-thyroid axis, helping normalise TSH secretion. Yogic postures involving neck flexion and deep breathing (such as Sarvangasana and Surya Namaskar) may directly enhance thyroid gland activity.

Secondly, the **serum levels of T3 and T4 hormones are expected to increase** in the intervention group. Aerobic exercise is known to improve metabolism and boost the conversion of T4 to T3—the active form of thyroid hormone.

A **reduction in blood glucose levels** is also an expected outcome. Subclinical hypothyroidism is often linked to insulin resistance and impaired glucose metabolism. Aerobic exercise increases insulin sensitivity and improves glucose uptake by muscles. Combined with stress-reducing yogic practices, this may lead to better glycemic control and overall metabolic balance.

In terms of statistical analysis, it is expected that the **intervention group will show significant improvements across all variables—TSH, T3, T4, and blood glucose—both within-group over time and between-group compared to the control**. The mid-intervention test (after 6 weeks) and post-test (after 12 weeks) should reveal a progressive trend in improvement, supporting the time-effect hypothesis.

Additionally, participants may experience **secondary benefits such as reduced fatigue, improved mood, and enhanced quality of life**. While these will not be formally measured in this study, improvements in thyroid and glucose profiles are typically associated with better physical and emotional well-being.

In summary, this research is expected to demonstrate that aerobic exercise and selected yogic asanas significantly improve TSH, T3, T4, and blood glucose levels in sedentary adult women with subclinical hypothyroidism. The results may contribute valuable insights into non-pharmacological approaches for hormonal regulation and overall health enhancement.

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